Sept. 5, 1950 W. S. MARTIN 2,521,591

APPARATUS FOR CONVERTING CRUSHED MATERIAL

Filed June 1, 1945 2 Sheets-Sheet 1

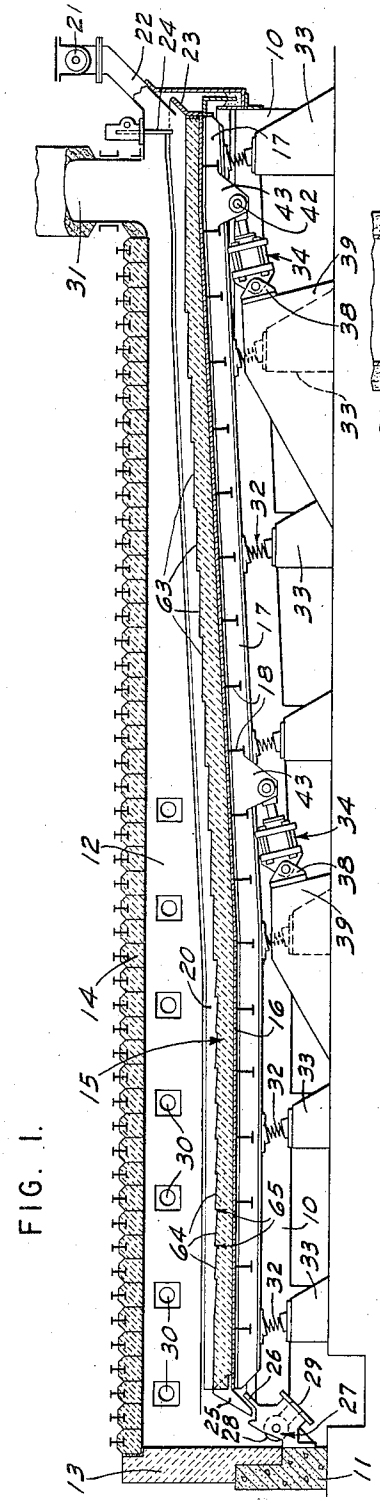


FIG. 1.

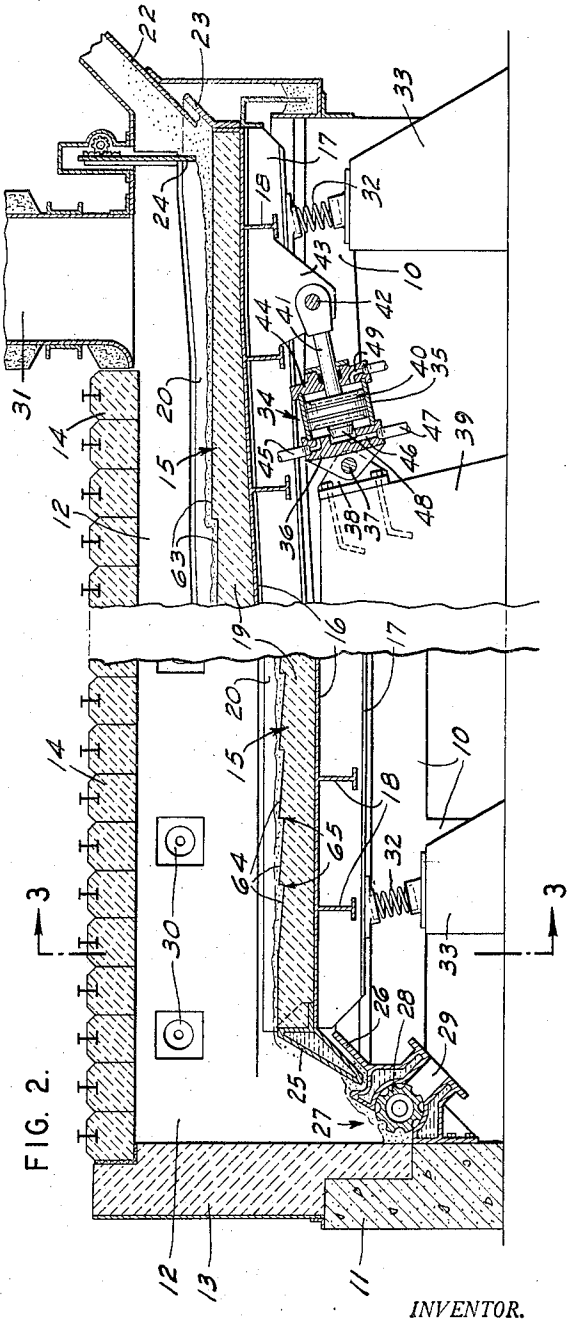


FIG. 2.

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FIG. 3.

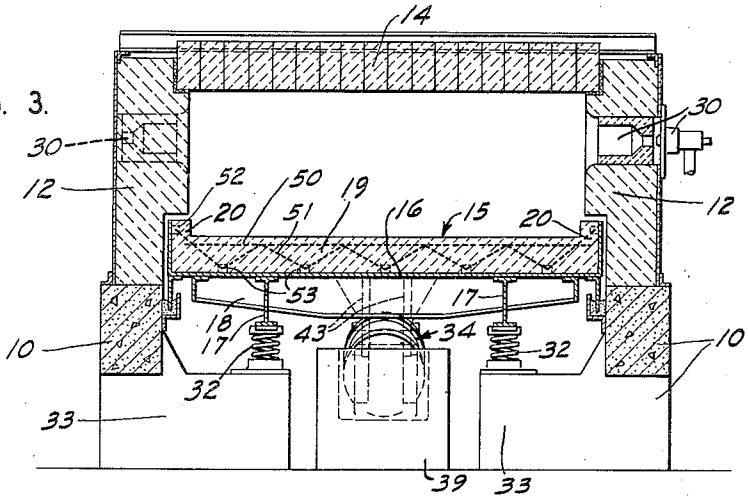
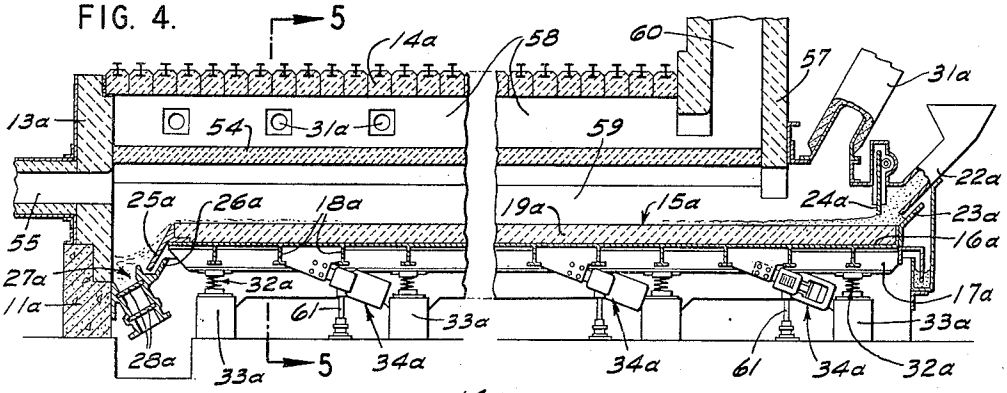


FIG. 4.



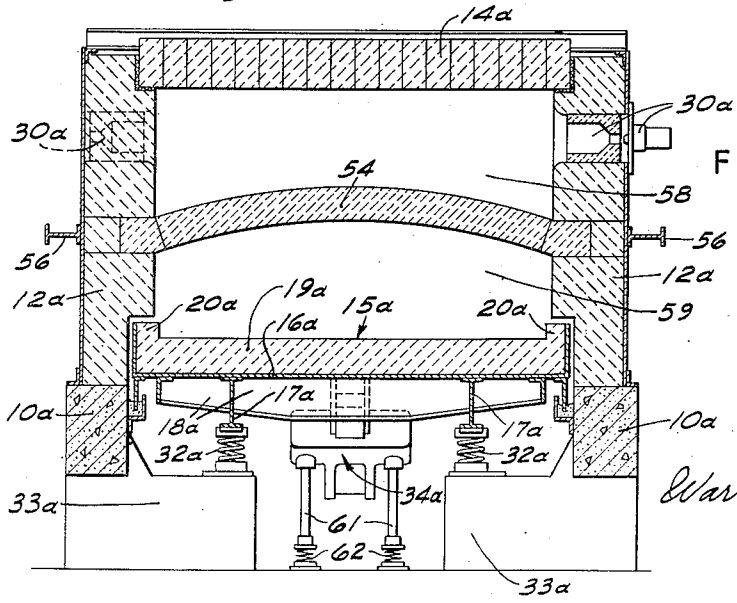


FIG. 5.

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APPARATUS FOR CONVERTING CRUSHED MATERIAL

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Application June 1, 1945, Serial No. 597,126

7 Claims. (Cl. 263—21)

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This invention relates to apparatus for converting crushed mineral material. More particularly, this invention relates to apparatus for continuous heat treatment of crushed material.

An important object of the invention is to provide a furnace with a vibratory deck or hearth serving as the bottom of the furnace, gas seals at the ends and sides of said deck and means beneath said deck for vibrating said deck.

According to one embodiment of the invention heat is applied directly to a material bed on the deck.

According to another embodiment of the invention, the heat may be applied to the upper surface of a muffle of suitable material such as carborundum and may be transmitted therethrough to gaseous material passing over the vibratory deck. Such gaseous material may be adapted to reduce material on said hearth.

Other objects, features and advantages will appear upon consideration of the following detailed description and of the drawings in which

Fig. 1 is a somewhat diagrammatic longitudinal vertical section of a furnace constituting one embodiment of the invention;

Fig. 2 is a view showing on a larger scale the ends of the furnace of Fig. 1, the central part being broken away;

Fig. 3 is a section taken along the line 3—3 of Fig. 2;

Fig. 4 is a longitudinal vertical section, similar to Fig. 2, of a modification; and

Fig. 5 is a vertical section taken along the line 5—5 of Fig. 4.

In Figs. 1, 2 and 3, there is illustrated a preferred embodiment of the furnace of the present invention. The foundation of any suitable material such as concrete comprises side walls 10 and a wall 11 at the discharge end of the furnace. Supported respectively by said foundation walls 10 and 11 are side walls 12 and a discharge end wall 13 of the furnace proper, these walls being constructed of suitable refractory material. At its top the furnace may have a flat roof 14 made up of members or blocks of refractory material suspended from I-beams supported at their ends on the side walls 12.

Extending across between the side walls 12 and substantially from end to end of the furnace is a vibratory deck or hearth 15 which serves as the bottom of the furnace proper and also as part of a vibrating feeder or conveyer. The material is opened up by this vibrating movement and the heat treatment is accelerated.

The hearth 15 comprises a box 16 carried by

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a suitable frame including longitudinal members 17 and transverse members 18. Said box which is illustrated on Fig. 3 as having high sides, may be filled to an intermediate level with a body 19 comprising heat insulating and refractory material having metal reinforcements (Fig. 3). This body 19 of refractory material is formed with side walls 20 to keep the material from escaping at the sides and these side walls and the side edges of the box 16 extend beneath overhanging portions of the side walls 12. Beneath the hearth or deck there is a gas seal extending completely around the periphery of the hearth. This seal may be of the lute type. In some cases it may be desired to use firebrick in constructing the body 19, in view of the abrasion-resisting quality of the brick.

Preferably the hearth 15 has a generally downward inclination from its inlet end to its outlet end near wall 13, and the upper surface of the refractory body 19 is formed with a plurality of successive steps so that the material is fed from step to step and is thoroughly turned over and opened.

As illustrated the material is supplied to the furnace through a feeder 21, and a chute 22 receiving material from the feeder and extending at its lower end over a lip 23 inclined outwardly from the upper edge of the adjacent end wall of the box 16. The lower end of said chute is secured to the top or roof of the furnace and is spaced from said lip 23 to prevent striking of the chute by said lip. The gap between the lip 23 and the end of the chute will be sealed by the material supplied in sufficient quantity to the chute 22 through the feeder 21. The flow of material into the furnace may be controlled by a sliding gate 24 extending through the top of the furnace, and in this way material may be accumulated to assure sealing of the apparatus at this point.

At its discharge end the vibratory hearth 15 is provided with a lip 25 overlying a lip 26 on the casing of a discharge device 27 having a rotary ribbed member 28 mounted in a part cylindrical chamber and discharging into an outlet 29. If desired the discharge stream may be divided and discharged through a plurality of discharge devices 27. The space between the lips 25 and 26 may be sealed by the treated material without preventing relative movement therebetween. If desired the lip 25 may be cooled in any suitable manner.

The furnace chamber may be heated by means of burners 30 projecting inwardly through the

upper parts of the side walls 12 near the discharge end of the furnace and extending as far toward the inlet end as desired.

The hot gases from the burning of fuel in the burners and also those produced by the treatment of the material may pass to the inlet end of the furnace and be discharged from the furnace through a flue 31 connected to the top of the furnace. In this travel of the hot gases over the material bed, there is a decided temperature drop indicating efficient utilization of the heat.

The hearth or deck 15 may be supported by inclined compression springs 32 interposed between the longitudinal members 17 and supports 33 which may be projecting portions of the side walls 10 of the foundation. The vibratory movement of the hearth may be effected by suitable vibrators 34, here illustrated as hydraulic vibrators comprising in each case a cylinder 35 having its base 36 connected by a pivot 37 to a bracket 38 on a fixed support 39 and a ram comprising a piston 40 in said cylinder and a piston rod 41 connected to said piston and to a pivot 42 in a bracket 43 projecting downwardly from said vibratory hearth or deck. At the free end of the cylinder, the piston rod 41 passes through the head 44 of the cylinder.

Fluid such as oil is admitted under pressure, through a duct 45 into the space between the cylinder base and the piston, long enough to move the piston outwardly the requisite distance and is then shut off. The oil is discharged through a duct 46 having a central entrance in said base 36, into an exhaust duct 47, when the piston is forced back in the return movement of the hearth. This return movement may be cushioned by means of a tapered plug 48 on the side of the piston opposite the piston rod and arranged to enter said central entrance of duct 46, where although it is too small in cross section to close said central entrance, it will progressively restrict the flow of fluid and cushion the return movement. It will be understood that a valve arrangement of known form may be utilized to open and close the connection between the duct 45 and the source of its supply and correspondingly close and open a connection between passage 46, duct 47 and a discharge line. The return movements may be assisted or produced by supplying fluid such as oil between the piston 40 and the head 44 through a duct 49 in the latter. This action may be effected by producing and relieving pressure in this part of the cylinder or by applying pressure from yielding means, such as spring means.

The refractory body 19 of the deck or bed 15 may be reinforced. As indicated in Fig. 3, this may be done, by providing metal reinforcing material 50 substantially parallel to the upper surface of the deck and transversely extending reinforcing material 51 attached to devices 52 in the side walls of the box 16 and carried downwardly and upwardly across the bed, being fastened at the low points to devices 53 secured to the bottom of the box and at the high points to the material 50.

It will be evident that the deck or hearth 15 is protected against contact with hot gases of combustion by the material thereon and that the discharge device 27 may be protected by the treated material by maintaining an accumulation of treated material thereover.

In Figs. 4 and 5, there is disclosed a modification which differs from the first form of furnace principally by providing a muffle 54 of suitable material such as carborundum extending across the furnace below the burners, 30a, an inlet 55 in the wall 13a through which suitable gases, CO for example, may be introduced beneath the muffle to assist in obtaining the desired result. In this form the material is heated by indirect or radiant heat.

The walls 12a receive the edges of the muffle 54 which may be arched, and in order to prevent spreading of these walls under lateral stresses thus produced, they may be supported by suitable means which may include I beams 56, engaging said walls at their outer faces.

Due to the use of the muffle 54, there are separate means for discharging gases from the two chambers separated by the muffle. In arranging for such separate discharge means, an arch-supported wall 57 may be provided to close the right hand end (Fig. 4) of the chamber 58 above the muffle. The chamber 59 below the muffle extends beneath the wall 57 to provide for a flue or stack 31a through which gases from the lower chamber 59 are discharged, and for a chute 22a through which material to be treated is fed into said lower chamber 59 and deposited on the vibrating hearth or deck 15a. At the left of wall 57 is an upright flue or stack 60 through which gases from the upper chamber 58 are discharged.

The hearth or deck 15a is supported in the same general way as the deck of the first form, by springs 32a interposed between deck frame members 17a and supports 33a. Vibration of the deck 15a may be effected in any suitable manner, for example by standard vibrators 34a connected to the frame of said deck or hearth 15a and yieldingly supported by struts 61 mounted on springs 62 carried by parts of the foundation.

At its inlet end the deck 15a is provided with a lip 23a beneath said chute 22a and spaced therefrom to avoid striking, the apparatus being sealed at this point by a suitable accumulation of material at this location under control of a vertically slidable gate 24a.

At its discharge end the deck 15a is provided with a lip 25a overlying a lip 26a of a discharge device 27a in which the discharge is controlled by slidable gates 28a operated alternately by hand or by a suitable operating device. It should be noted that in the form of apparatus illustrated in Fig. 4, the hearth 15a is substantially horizontal and the muffle 54 is similarly arranged.

Although the hearth 15 of the first form of the apparatus has been described generally as having one end higher than the other and as having steps at its upper surface, there has been no description of various features which appear to be of importance and which will now be considered.

The upper surface of said deck 15 slopes downwardly from its receiving end to an intermediate point and then extends substantially horizontally to its discharge end. In the sloping or inclined portion of the hearth 15 there are broad steps 63 with generally flat tops and in the horizontal part there are narrow steps 64 of which the tops slope downwardly and rearwardly. The forward edges of steps 64 are substantially in the same horizontal plane and between these forward edges are pockets 65 located at the bottoms of the steps. The broad steps 63 retain the material thereon for a longer period than would narrower steps and decrease the number of times the material is rolled over, as when it rolls off a step.

In passing along the steps 64 in the horizontal

part of the hearth 15, the larger and heavier objects or particles sink into the pockets 65 and are held back with reference to the lighter particles so as to receive additional treatment and be broken down. By having the burners 30 close to the material bed as in the first form, the heat from the burner flames passes largely by radiation directly to the material bed and is absorbed thereby. In the second form of furnace, the burners are close to the muffle 54 and the greater part of the heat from the adjacent burners 30*a* passes by direct radiation to the muffle and from the other side of the muffle the heat passes by radiation to the material bed.

It should be understood that the positions of the discharge flues and the burners may be varied to control the heating in different parts of the furnace.

It should be understood that various changes may be made and that certain features may be used without others, without departing from the true scope and spirit of the invention.

Having thus described my invention, I claim:

1. A high temperature heat treatment furnace comprising a chamber lined with refractory material and having as its bottom a vibratory refractory deck effective to feed therealong a bed of crushed mineral material and the like, means for vibrating said deck positioned beneath said deck, gas seal means at the side edges of said deck, gas seal means for introducing such material into the chamber and depositing it on the receiving end of said deck, gas seal means for receiving material from the discharge end of said deck and discharging it from the furnace, a gas outlet above said receiving end, and heating means for the material on said deck including burners in said chamber and spaced from said outlet.

2. A furnace comprising a chamber lined with refractory material having as its bottom a refractory vibratory hearth having a downwardly inclined portion at its receiving end and then a flat portion inclined upwardly from the plane of said inclined portion.

3. The combination according to claim 2 wherein said downwardly inclined portion has steps with wide substantially horizontal tops.

4. The combination according to claim 2 wherein said flat portion is provided with steps inclined rearwardly to form pockets to the front of said steps to receive and retain for additional treatment the larger and heavier bodies.

5. A high temperature heat treatment furnace comprising a chamber lined with refractory material and having as its bottom a vibratory deck effective to feed therealong a bed of crushed mineral material, means for vibrating said deck beneath said deck, said deck having an upper face of refractory material, gas seals between said vibratory deck and the side walls of said chamber, gas seal means for introducing such material into the chamber and depositing it on the receiving end of said deck, gas seal means for receiving material from the discharge end of said deck and discharging it from the furnace, means for subjecting the material at the discharge end of said deck to high temperatures, and means for discharging resulting high temperature gases from the receiving end of said furnace.

6. A high temperature furnace as set forth in claim 1 wherein said vibratory deck is provided with a plurality of steps to cause the material to roll over as it passes from step to step toward the discharge end of the deck.

7. A high temperature furnace as set forth in claim 1 wherein there is a muffle beneath said burners and over said vibratory deck to radiate heat thereto, a flue to draw gases from the part of the chamber above said muffle, and a flue to draw gases from the part of the chamber below said muffle.

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